

# R&D on offshore wind power plants

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# ECN Wind Energy

## R&D on offshore wind power plants

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NORCOWE  
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# Energy Research Centre of the Netherlands



- ECN is the largest, independent, market oriented and innovative Dutch energy research institute.
- ECN investigates and develops technologies and products for a safe, efficient and environment-friendly energy supply with 600 fte.
- With and for the market the energy technology is developed by ECN.



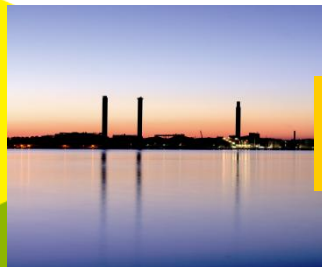
Solar energy



Biomass



Wind energy



Efficiency & Infrastructure



Policy Studies

# ECN Wind R&D Strategy

## Offshore Wind Power Plants

**Reduce COE of Offshore Wind Power Plants**

Planning &  
Design

Construction

Operations

80% of EU offshore wind farms have been realised with ECN support

By 2015  
ECN will have facilities for  
14MW+ prototype turbines

Top industrial players  
are exploiting ECN  
technology and knowledge

# A Wind of Change

## Working with the industry

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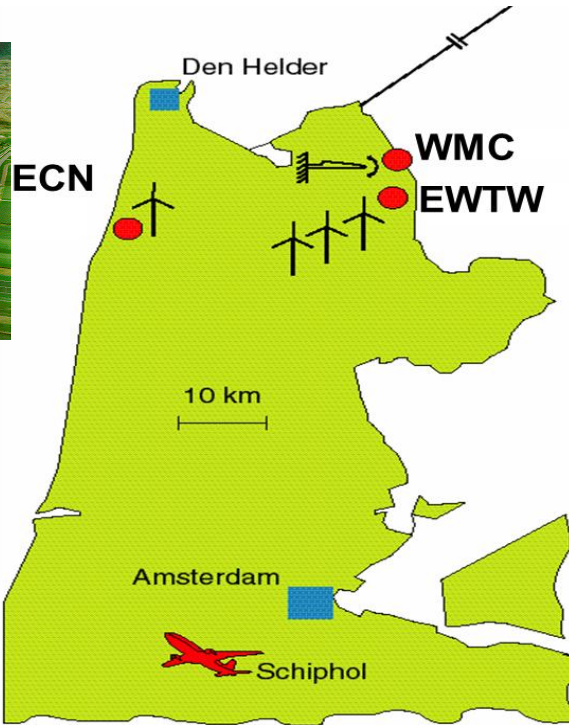


1. Turbine performance improvement
2. Component analysis
3. Software based analysis
4. Onshore development
5. Wind turbine + wind farm



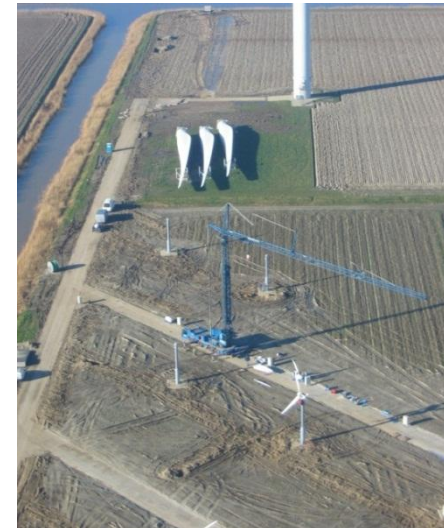
1. Wind farm performance improvement
2. Component analysis for wind farms
3. Simulated & Measured improvement
4. Offshore development
5. Integrated wind farm approach

# ECN: Developing wind since 1974



Metmast IJmuiden

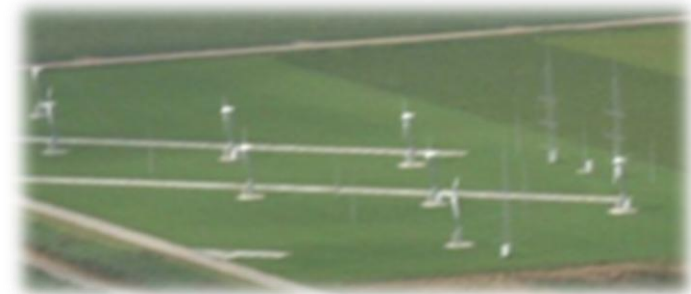
OWEZ



## ECN Wind Turbine Test site Wieringermeer (EWTW)



- Five 2.5MW research turbines N80 with one 108m high meteorological mast
- Five locations for prototype turbines with meteorological masts (108m, 108m, 100m and 100m)
- Measurement Infrastructure
- Measurement Pavilion

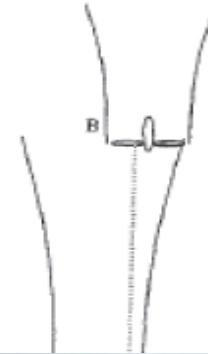


- Scale Wind farm

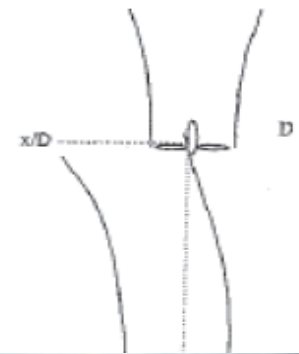
# Wind Farm Control

- Yaw upstream turbine :
  - Less power (higher loads)
  - Yaw deflects wake
- Downstream turbines yield higher product

aligned



yawed



Test ongoing in  
ECN scale wind farm



# Offshore facilities

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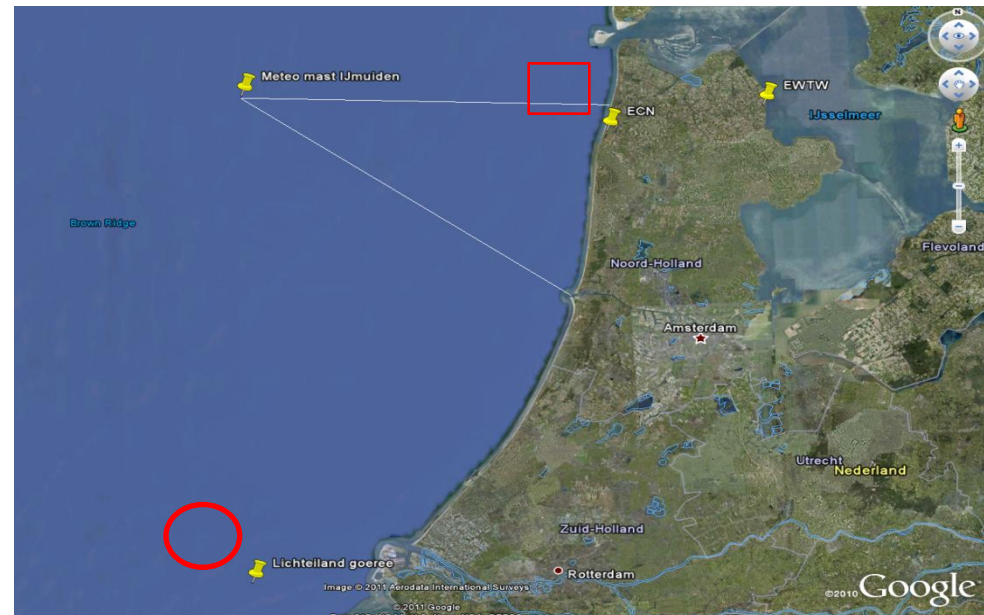


- Measurement and evaluation programme Egmond aan Zee
- Various demonstrations of innovations in offshore wind farms
- Measurement Mast IJmuiden
- Goal: demonstration of innovations with industry in offshore wind farm 'Leeghwater' previously known as 'Proeftuin op Zee'



# Lidar systems at operation

- Meteo mast IJmuiden
  - Offshore
  - 75 km from IJmuiden
  - At the height of Callantsoog
- EWTW
  - On shore
  - Flat, agricultural terrain
  - About 35km from ECN
- 'Lichteiland' Goeree
  - Offshore
  - KNMI measurement station
  - About 30km from shore



	Operationaliteit	Capaciteit (MW)	Ontwerp en Engineering	Fundering	Turbines	Installatie	Onderhoud	Ontwikkeling en operatie	Overig
Vindeby	1991	5							
Lely	1994	2							
Tunø Knob	1995	5							
Irene Vorrink	1996	17							
Bockstigen	1998	3							
Blyth Offshore	2000	4							
Middelgrunden	2000	40							
Utgrunden I	2000	11							
Yttre Stengrund	2001	10							
Horns Rev I	2002	180							
Frederikshavn	2003	11							
Nysted	2003	168							
Samsø	2003	23							
North Hoyle	2003	60							
Arklow Bank	2004	25							
Scroby Sands	2004	60							
Kentish Flats	2005	90							
OWEZ	2006	108							
Barrow	2006	90							
Lillgrund	2007	110							
Burbo Bank	2007	90							
Prinses Amalia	2008	120							
Inner Dowsing	2009	97							
Lynn	2009	97							
Rhyl Flats	2009	90							
Horns Rev II	2009	209							
Robin Rigg	2009	180							
Gunfleet Sands	2009	173							
Alpha Ventus	2010	60							
Belwind I	2010	185							
Rødsand II	2010	207							
BARD 1	2010	400							
Thanet	2010	300							
Walney I	2010	184							
Greater Gabbard	2010	504							
EnBW Baltic I	2010	630							
Ormonde	2011	150							
Sheringham Shoal	2011	317							
Walney II	2011	184							
London Array	2011	185							
Thornton Bank II	2012	48							
Anholt	2013	111							
Thornton Bank III	2013	400							
Lincs	2013	270							
Borkum West II	2014	200							

- Offshore wind will be a economically large sector.
- ECN together with the Dutch industry has gain a top-position in realising the offshore wind farms.
- Strategic R&D-focus ECN:  
**Offshore wind power plants**



**QUESTIONS?**

**ECN**

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# Strategic Alliances ECN Wind – R&D partners

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- TU Delft: strategic partner with Collaborative R&D programme.



- WMC: strategic partner with Collaborative R&D programme.



- EERA JPWind: Coordinator programme Aerodynamics and member of the board.  
(a.o. DTU, Fraunhofer, CENER, CRES, Sintef, Forwind, TUDelft, WMC)



- MARIN: Collaborative R&D through JIPs



- NREL: CRADA. Collaborative R&D activities



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